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It is hereby certified that annexed here to is a true copy of **Application, Provisional Specification & Abstract** of the patent application as filed and detailed below:-

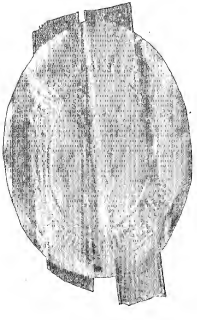
Date of application : **15-12-2003**

Application No : **1015/CHE/2003**

Applicants : **M/s. Matrixview Pte Ltd, 9, Shenton Way #05-02, Singapore 068813.**

In witness there of
I have here unto set my hand

Dated this the 18th day of March 2005
27th day of Phalguna, 1926(Saka)



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15/XII

ORIGINAL

FORM 1

The Patents Act 1970
(39 of 1970)

GOVT. OF INDIA
011809
15 DEC 2003
PATENT OFFICE (BR.) CHENNAI

APPLICATION FOR GRANT OF A PATENT
(See sec.5 (2), 7, 54 and 135 and Rule 33A)

1015/CHE/2003
15.12.2003

Matrixview Pte Ltd
9 Shenton Way #05-02
Singapore 068813
Tel: (65) 6336 2777

1. Hereby declare –
   (a) That we are in possession of an invention titled **"BIT PLANE BASED ARCHITECTURE FOR LOSSLESS DATA COMPRESSION"**
   (b) That the Provisional Specification relating to this invention is filed with this application.
   (c) That there is no lawful ground of objection to the grant of a patent to us.

2. Further declare that the inventor for the said invention is,

   Arvind Thiagarajan
   H 24/6, Vaigai Street, Besant Nagar
   Chennai 600090. Nationality - Indian

3. We, claim the priority from the application(s) field in convention countries, particulars of which are as follows:-

   Not applicable

4. We state that the said invention is an improvement in or modification of the invention, the particulars of which are as follows and of which we are the applicant/patentee:

   Not applicable

5. We state that the application is divided out of our application, the particulars of which are given below and pray that is application deemed to have been filed on _____ under section 16 of the act.

   Not applicable

15 DEC 2003 1015/CHE/03

6. That we are the assignee of the true and first inventor.

Not applicable

7. That our address for service in India is as follows:

Matrix View Technologies (India) Private Limited
No.69, Mahalakshmi Koil Sreet
Kalakshetra Colony, Besant Nagar
Chennai 600090. TAMILNADU. INDIA.

8. Following declaration was given by the inventor or applicant in the convention country declare that the applicant herein is our assignee or legal representative

Not applicable

9. That to the best of my knowledge, information and belief the facts and matters stated herein the correct and that there is no lawful ground of objection to the grant of patent to us on this application.

Mr. Arvind Thiagarajan
(Inventor)

10. Following are the attachment with the application:

a) Provisional specification (3 copies)
b) Fee of Rs.

I request that a patent may be granted to us for the said invention

Dated at Chennai on this 11th day of December, 2003

Mr. Anand Thyagarajan
(Authorized Signatory)

To

The Controller of Patents
The Patent Office
At Chennai

ORIGINAL

FORM 2

The Patents Act, 1970

Provisional Specification

Section 10

"BIT PLANE BASED ARCHITECTURE FOR LOSSLESS DATA COMPRESSION"

Applicant:

Matrixview Pte Ltd
9 Shenton Way #05-02
Singapore 068813
Tel: (65) 6336 2777

The following Provisional Specification describes the nature of the invention and the manner in which it is to be performed.

Field of Invention

The Present Invention relates to the composition and architecture on Bit Plane for Lossless compression of image or other highly correlated data streams.

Background of Invention

The role of data and image compression assumes significant importance as the world makes a paradigm shift from analog to digital systems. Data compression, which was impossible due to the inherent disadvantages of the analog systems, has become a feasible reality with digital systems. The computational overheads and the complexity posed the most serious threat to the development data compression. With the advent of high-speed digital processors with MIPS capability most of these problems have been overcome.

Present Invention is a perfectly loss less technique (i.e. pixel to pixel loss less with zero Means Square Error M.S.E). To compress highly correlated images and data. The algorithm renders a high compression ratio without any errors or loss of data.

The Present Invention algorithm employs bit plane indexing to increase redundancy and enhance compression. Bit plane indexing involves a simple, logical mathematic comparison, which is loss less.

Current Technologies

Image compression technologies can be broadly classified as either Lossy or lossless. An image compression technology can be classified as Lossy or Lossless depending on whether the subsequent decompression of the compressed data produces an exact pixel-to-pixel replica of the original data or not.

We can logically infer from the above that any efficient compression technique requires a transformation also known as pre – coding, which in turn aids in increasing the efficiency of the second step, the entropy coder. At this stage it must be emphasized that if the entropy coder has to produce good compression ratios then the pre – coding should transform the data into a form suitable for the entropy code. If the transformation is not efficient enough then the entropy coder is rendered redundant. Hence it can be logically concluded that the pre- coding or the transformation is the most important stage of any image compression algorithm

The most popular pre – coding transformation used in image compression is the Discrete Cosine Transform (DCT). This transformation gives the frequency and extent of data change inside the Image. Another important property of any transformation is that it should be reversible too, so that the reverse process can be applied at the decompression stage to obtain the original image. This transformation is extensively used in the JPEG algorithms and its variants

As indicated above DCT is a reversible transform whose forward transform is given as

$$DCT(i,j) = \frac{1}{\sqrt{2N}} C(i)C(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right]$$

where $C(x) = \frac{1}{\sqrt{2}}$ if $x = 0$, else 1 if $x > 0$.

DCT(i, j) = C(i).C(j). Σ Σ f(x,y).....

The above-mentioned technique poses the following problems

The complexity of the equation in terms of the number of multiplications and additions, The most straightforward way to implement the DCT is to use the defining Equation In the 2D case, with arrays of dimensions $N \times N$, the number of multiplications is on the order of $2N^3$ using a separable approach of computing 1D row and column DCT's. Specifically, for an 8 × 8 pixel array, which is used in the JPEG family we have 1024 multiplications and 896 additions. In spite of the tremendous improvement made in terms of reducing the number of computations, the reduction has not been significant enough to reduce the tremendous overhead it places on the hardware that implements the algorithm.

Even though the image data is an integer their multiplication to cosine terms in the formula produces fractional numbers or real numbers because cosine values are fractional in nature until and unless the integers are in multiples of Pi, which might not be the case. Since fractional numbers need infinite precision to store them exactly they might produce errors in the reverse process resulting in losses, which mean that they are no longer pixel to pixel lossless.

Another popular transformation used is called the wavelet transform, which is used in the latest image compression techniques like JPEG2000. This uses a mother wavelet to decompose the image data into frequency sub - bands, which in turn increases the redundancy in most of the sub – bands hence improving compression ratios. Used in their original form the mother wavelets do not give integer-to-integer transformation but when used after a process called lifting they become integer-to-integer transforms thereby making the entire process lossless.

Color Transformations also offer an interesting prospect to compression. Commonly used color space is RGB where every pixel is quantized by using a combination of Red Green and Blue (Primary Colors) values. This format is ideally suited for designers but no so ideal for a compression algorithm. As indicated above the human eye is more sensitive to luminance than color hence Chrominance Luminance and Value format offers an interesting perspective to compression.

Description and principle

Compression algorithms like JPEG and JPEG 2000 can be used only for color images. This makes their application restricted to images with certain combination of color only.

The Present Invention algorithm **employs the bit plane approach that gives a unique flexibility that no other algorithm gives,** in the sense that it can be applied **to a wide range of image type** (e.g. Bi – level, grayscale, 8/16/24 – Bit color, medical images etc.) **without any change in the structure of the algorithm.**

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Description

Image data is highly correlated i.e., adjacent pixels are closely related. Hence it is possible to create a significant redundancy, which is then followed by a unique

which comprises of an arithmetic coder preceded by a Run length encoder. The Bit-Planes transformation primarily has four variants

1. Horizontal Variant
2. Vertical Variant
3. Predict Variant
4. Multidimensional Variant

The Horizontal, Vertical Predict Variants can also be classified as 1 – Dimensional and Multidimensional Variant can be classified 2 – Dimensional. The data re – arranging stage comprises of the following steps

1. Reversible – Sort process
2. Last to First re–arrangement

The Bit plane indexing method creates two arrays of codes, one represents the index of the rearranged and sorted image and a set of zeros and ones that form the bitplane.

Horizontal Variant

This being a one-dimensional category only one bit-plane is used to code the repetition i.e. in the horizontal direction. In this method adjacent data elements (in the case of images pixels) are scanned in raster order (i.e. from left to right and then from top to bottom) and If both of them are equal then a value of '1' is stored in a matrix called "Bit-plane". Otherwise a value of '0' is stored in the "Bit-plane" matrix. Only this different value is only stored in a matrix instead of storing all the

repeating values. This method transforms the input data into a "bit – plane" which has a greater amount of redundancy than the original image data.

This operation only requires a logical mathematic comparison and no other mathematical calculation. As indicated, the entire process falls in to the integer - to - integer domain hence maintaining the lossless nature of the entire algorithm. This can be further enhanced by the fact that for e.g. if a pixel is represented by 8 – bits, the logical transformation performed in compression maps it to another number that also requires only 8 – bits to be represented. Hence guaranteeing to preserve the perfectly lossless property.

Vertical Variant

Vertical variant is an exact replica of the horizontal variant method, except for the fact that data is compared in a non – raster fashion (top to bottom first and then from left to right). This process again does not affect the perfectly lossless nature of the transformation.

Predict Variant

This process offers a slight variation from the horizontal and vertical Variant methods. This variant compares two adjacent values in raster order, if they are same then it stores the value in a matrix named "bit – plane" and gives a mapping value to the repeatedly occurring elements and stores them in another matrix named "data – plane". This method has been very useful in medical images where different values keep repeating themselves, where all these repetitions are replaced by a single mapping value and the actual value is store in the "data – plane".

This method too performs only logical transformations to the data and there is no other mathematical operations which distort the lossless property of the transform.

Multidimensional Bit Plane

This performs a combination of Horizontal and Vertical Bit Planes, and has been found to achieve better compression ratios in some cases. This first performs horizontal compression and stores the "bit - plane" generated by this as "Bit – plane horizontal" and then performs vertical compression and stores the "bit – plane" generated by this as "Bit – plane vertical". A logical "OR" is performed to the two bit - planes and stored as "Lossless Compressed Multidimensional Bit – plane". To this bit plane" a "NOT" operation is performed between the original image matrix and the "Lossless Compressed Multidimensional Bit – plane". The salient feature of this is that both the logical operations, compare "OR" and "NOT", maintain the integrity of the image data thereby maintaining the lossless property of the transformation.

Thus the raw data is decomposed to the above mentioned types of Bit-Planes and are stored along with the index of the Image. The reconstruction can be done losslessly using the Index and Bit-Plane.

Applications of the Present Invention

Present Invention can be used in a wide gamut of applications ranging from Medical Imaging to Digital Entertainment to Document management. Each of these

verticals requires Repetition Coded Compression to be implemented in its own unique way to deliver a robust and powerful end product.

Present Invention could be deployed in the following forms for commercialization.

1. Chip – (ASIC7, FPGA etc.)
2. DSP, Embedded Systems
3. Standalone Hardware boxes
4. Licensable Software (as DLL's OCX etc.)
5. Software deliverables

Thus, the above mentioned account describes the invention in detail. It is intended that the foregoing description is only illustrative of the present invention and it is not intended that this unique invention be limited or restricted thereto.

Many specific embodiments of this novel invention will be apparent to one, skilled in the art from the foregoing disclosure. The scope of the invention should be determined not only with reference to the above description but to all other additions, substitutions & modification of the present invention without departing from the spirit of this invention.

Abstract

Present Invention is a perfectly loss less technique (i.e. pixel to pixel loss less with zero Means Square Error M.S.E) to compress highly correlated images and data. The algorithm renders a high compression ratio without any errors or loss of data.

The Present Invention algorithm employs bit plane indexing to increase redundancy and enhance compression. Bit plane indexing involves a simple, logical mathematic comparison which is lossless.

Compression algorithms like JPEG and JPEG 2000 can be used only for color images. This makes their application restricted to images with certain combination of color only.

The Present Invention algorithm employs the bit plane approach that gives a unique flexibility that no other algorithm gives, in the sense that it can be applied to a wide range of image type (e.g. Bi – level, grayscale, 8/16/24 – Bit color, medical images etc.) without any change in the structure of the algorithm.

Bit plane indexing creates a redundant array of only zeros and ones. This improves the compression ratio without any loss or increase in the data set . This step is critical to obtain a high compression ratio to respond to speed.

In the bit plane indexing process, the raw data is decomposed to various types of bit planes, like Horizontal, Vertical or a combination of both in an integer to integer matrix. A bitplane of zeros and ones is obtained along with the index of the image. The original image can be reconstructed perfectly losslesly with the index and the bit plane.